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The French Ardennes

Why we chose to spend a short holiday in the neighbourhood of Charleville-Mézières is still not clear in our minds. As a fourth-former, we perhaps, whilst patiently ploughing our way through "As You Like It," imbibed something of the romance of the Forest of Arden. Then we had a somewhat nebulous memory of a pleasant visit there some twenty years ago, when a local foundry owner showed us his plant, staffed with a mixture of hard-working French and Belgians. Finally, there was the practical thought that if some awkward strike occurred, we could change the *locale* of our holidays to the Belgian Ardennes.

A formal visit on our arrival to Mr. Guillet, the secretary of the local Chamber of Commerce, to thank him for some courtesies extended to us before our departure, revealed the fact that he was also the secretary of the local foundry employers' association. Moreover, as there was to be a regional technical conference, we were invited to give an informal address. From that moment onwards we received in the fullest measure the most generous hospitality, especially from Mr. Gailly, the well-known founder of malleable-iron fittings; Mr. Le Beau, the president; Mr. Cury, the vice-president, and Mr. Le Thomas, the director of the "Centre Technique," who was the chief lecturer at this small congress.

We did not visit any works, so what we now disclose is just the result of gossip with our hosts. Current production is now running at 80 per cent. of pre-war. Raw materials are in short supply and their quality is not all that could be desired. Belgian labour, which was excellent, is no longer available. Attempts to make up the acute shortage of man-power by the introduction of Italians has not been entirely satisfactory, though one owner had a few who were working well; another had lost all his, as the men so thoroughly disliked the quality of the local bread. We endorse that it is not very palatable, being made of maize. However, for the rest, the food is excellent. Meat, eggs, fruit are in unlimited supply. A meal consisting of tomato and potato salads, pork sausages and mixed vegetables and cherries in a workman's restaurant cost about 2s. An extra dish, however, would involve a payment of three or four shillings. For eleven years or so a five-day week of nine hours a day has been, as is still being, worked. Canteens installed during the war no longer function. The French foundry industry has the intention to spend to some milliards of francs on modernisation. There is a hope that much of this will be spent in Great Britain, but only for actual plant. Processes will not be bought, for, as it was neatly put by one of our friends, "We do not intend to import brains, as we firmly believe we have more than enough indigenous grey matter, leaving quite a margin for export." Finally, the disregard of the value of their own money—a factor reported on during earlier visits to France, is still more pronounced. The tendency to change money into capital and, preferably, portable goods, is everywhere noticeable. It is action which needs arresting if serious inflation is to be averted. The Falkirk of France has, indeed, much to recommend it as a holiday centre, especially for those interested in foundry practice.

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Research on Cast Iron

Investigations by B.C.I.R.A.

The British Cast Iron Research Association held their fourth annual visit of members to their premises at Alvechurch, Birmingham, on July 9. Some 200 visitors were conducted around the attractive country H.Q., Bordesley Hall, which was taken over by B.C.I.R.A. and officially opened in March, 1943. The exhibits showing work in progress were attractively laid out, and the whole afternoon was well organised and efficiently run. Despite a sharp but heavy thunderstorm during proceedings, members were able to get around and see sufficient of the laboratories and buildings to form a comprehensive picture of the scope and progress of work under way.

The work of the Development Department, as indicated by the exhibits, deals with the application to the ironfoundry industry of results obtained from research investigations. The major work is in dealing with problems experienced by members and, if necessary, investigating such problems in members' works. The programme at present includes:—(1) Composition, structure and strength of cast iron, *i.e.*, relationship between chemical composition and the mechanical strength of unalloyed cast irons; (2) warping and cracking of light castings; (3) carbon monoxide hazards in the foundry; (4) chaplets; (5) welding of cast iron, and (6) shrinkage and feeding.

The "Engineering Uses" Division provides services for engineering foundries and users, covering casting design, service failures due to faulty design, data for engineering design of castings, the extended uses of cast iron, etc. In parallel with the "Building Uses" Division, this division forms source of information on the industrial uses of cast iron. The Intelligence Department is responsible, among other duties, for editing the Association's publications.

The current research programme covers investigations of two kinds, those which are fundamental in character and of interest to the whole industry, and those which are directed to the solution of specific or individual problems. The Research Department includes in its scope various service laboratories in which particular tests can be conducted for any other department. These include laboratories for miscroscopic examination and chemical analysis, machine shop, mechanical testing laboratory, experimental foundry, sands laboratory, etc. Investigations include work on graphite formation, decarburisation of cast iron, high-duty cast irons, mechanical properties in relation to design, inclusions and gases, ingot moulds and corrosion.

In a new special tests laboratory are housed a large creep-testing machine, a fatigue testing machine, a damping capacity tester and a hydraulic unit of 50-tons capacity for the determination of stress-strain curves at elevated temperatures and testing at sub-zero temperatures. Apparatus for strain determination by resistance strain gauges is under construction.

New Laboratories for Instrument Research

Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, speaking at a lunch in London on July 10 to celebrate the opening of the new laboratories of the British Scientific Instrument Research Association, said that the British scientist succeeded in war-time not only because he wished to serve his fellow countrymen in the armed forces, but also because he was stimulated by the constant challenge from the user of his results to his professional pride and skill. He visualised the scientific instrument industry as being situated at the corner of a triangle, the other concerns being occupied by science and by the users of instruments. From the development of science came "the warp and weft from which the fabric of instruments was made." From user needs came the prompting of definite objectives. It was a good thing for a research organisation to have such stimulation from the user. In its move toward greater efficiency, British industry would make more exacting demands on the ideas and products of the British Scientific Instrument Research Association. Sir Edward was confident that this challenge would be accepted.

Austempering Cast-Iron Cylinder Liners

Austempering, the heat-treatment process which consists of quenching in a constant-temperature salt bath, has recently been used with success for cylinder liners for internal-combustion engines. It is necessary, in the heat-treatment of cylinder liners, to obtain a stress-free, uniformly-hardened structure, and to avoid distortion and surface decarburisation. It seemed, according to C. W. Ohly, writing recently in "Materials and Methods," that the solution to these three problems lay in working out a suitable isothermal treatment. Iron of the following average analysis is used for cylinder liners by Thompson Products, Inc.:—Total C, 3.10 to 3.45; combined C, 0.60 (max.); Si. 1.95 to 2.35; Mn, 0.55 to 0.90; P, 0.25 (max.); S, 0.10 (max.); Cr, 0.25 to 0.50; Ni, 0.25 to 0.50; Mo, 0.25 to 0.50 per cent. Time-transformation-temperature curves were not available for this iron, but its hardenability characteristics were found to resemble those of the S.A.E. steels with similar carbon and alloy content.

In the production use of austempering, four immersed-electrode salt-bath furnaces are used, the baths being used for preheating, heating, quenching and stress relieving. The nitrate quenching bath is kept agitated by compressed air fed in at the bottom, together with a motor-driven propeller. After austempering, the hardness variation over the surface is not greater than three points Rockwell C. Whereas the structure of the iron after the oil quenching shows acicular primary martensite, austempering gives a bainitic matrix. Substantial savings in materials and time are claimed for austempering as compared with the conventional oil-quenching method.

Principles of Precision Investment Casting*

Part I

By Kenneth Geist† and Robert M. Kerr, Jr.‡

I. HISTORY

Precision investment casting, using the lost wax process, has come to use from three different sources. The first was art or sculpture. Probably the first recorded use of this process was made by the Chinese several thousand years B.C. With the exceptions of a few fleeting instances, little is known of the progress of this art until about the 16th century. During the 16th century, Benvenuto Cellini cast many of his figures and objects of art using the lost wax process, or as it was known in those days, "cire perdue." Like other of his contemporary artistic countrymen such as Raphael and Stradivarius, he kept his method secret, hence the process was lost for several hundred years. The lost wax process was rediscovered in 1897 by a dentist, B. F. Philbrook, of Iowa. Real recognition, however, usually is given to W. H. Taggart.

The dental profession provided the second source by supplying complete casting outfit and necessary materials to produce precision castings. Although materials and methods have been greatly improved and perfected, the original process is still essentially the same. The dental profession has greatly enlarged this second source by the constant research carried out by dentists, dental schools, the American Dental Association Research Benefit, the National Bureau of Standards, and the Dental Manufacturers.

In the early 1930's the jewellery trade supplied the third source of information and technique. It was a logical step that this process should be adapted to a related art, the casting of precious alloys for jewellery. The jeweller, while not so demanding in dimensional accuracy, does require intricate shapes with smooth surfaces and minute detail, with the further requirements of many similar castings from one master. They were interested primarily in production of engagement, signet, and wedding rings. The better grades of these rings have always been stamped in two pieces, formed into semi-circles, and then soldered together. This necessitated a very large investment in stamping dies.

The sale of rings is seasonal and new models are brought out each year. The manufacturing jeweller found himself in the unpleasant position of making up a great number of new models with a corresponding number of stamping dies, sending these out with his salesmen to the trade, and having these salesmen report that only two or three of the samples were acceptable to the customers. This necessitated the scrapping of many dies, so the manufacturing jeweller turned to the dentist's process.

The only thing he could not get from dentistry was the method of making thousands of castings all alike, so the manufacturing jeweller developed a permanent die; his contribution to the lost wax process.

Hence comes the information and technique, combined from three sources; the arts, contributing the fundamentals of the process, the dental profession, contributing accuracy, smoothness, and fine detail, the jewellery trade contributing the permanent die as a means of producing thousands of castings all alike.

The logical step was into the industrial precision investment casting. First it is proposed to discuss the various steps in precision casting, and outline the various methods for accomplishing these steps.

II. STEPS IN THE PROCESS

Briefly, the sequence of operation to produce castings starting from the blueprints is as follows:—

1. A master pattern is produced incorporating all the shrinkage allowances.
2. A die is produced which is a negative of the pattern.

2A. Frequently step 1 is eliminated and a metal die similar to a die cast and a plaster moulding die is made by conventional methods.

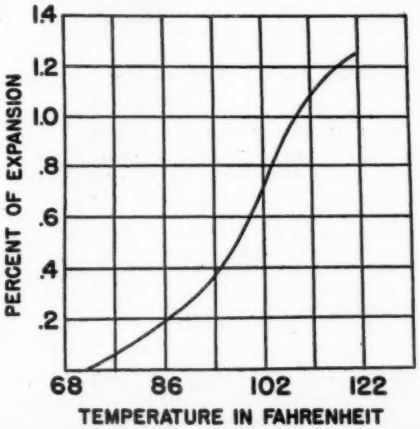

FIG. 1.—THERMAL EXPANSION OF A TYPICAL CASTING WAX.

*Exchange Paper of the American Foundrymen's Association, presented at the 44th Annual Conference of the Institute of British Foundrymen at Nottingham, June 19.

†Technical engineer in charge of precision casting at Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

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Precision Investment Casting

3. An expendable pattern is produced from the die.
4. A number of patterns are assembled together on an expendable gate to form a group for economical casting.
5. A flask is placed around the group and the investment is poured in.
6. The mould is allowed to set and is then placed in a low temperature oven to eliminate the pattern and help to complete the chemical reaction.
7. The mould is placed in the furnace and fired at 425 deg. C. to 1,150 deg. C.
8. The metal is melted and cast into the hot mould.
9. The castings are cleaned and given surface treatment.
10. Heat treatment or straightening operations are performed if necessary.

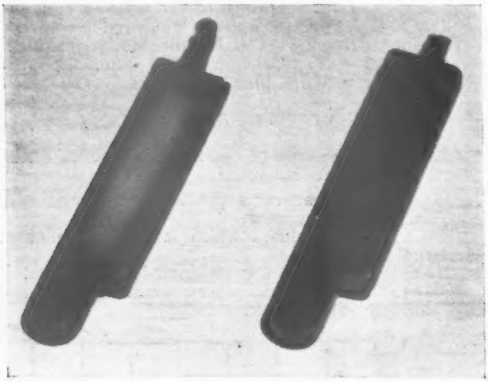

FIG. 2.—SHOWING THE INFLUENCE OF INJECTING UNDER PRESSURE.

1. *Production of the Master Pattern.*

When a precision caster is considering an item to be made, one of his first decisions is whether to make a master pattern or to sink a die directly from the blueprint. The factors which influence this decision are:—(*a*) Equipment of the tool room; (*b*) complexity of the item; and (*c*) size of the order.

Normally, it takes a rather complete tool room to sink a die. It is usually easier to make a pattern and cast a die from it. However, if the order be large, it is probably more economical to sink a steel die because the die life is so much greater than that of the cast die.

The majority of the shops make up the master pattern of die incorporating all the shrinkage allowances. These include shrinkage of the die material, expendable patterns, and metal. There usually is an expansion of the investment so that this must be deducted from the total shrinkage. Some shops make a master pattern to the exact size of the casting, and depend upon the expansion of the investment to compensate for all the shrinkage. The pattern, when completed, includes all of the pins, cores, core prints, draft, etc., that are needed. The patterns may be made of brass, steel, cast stone, wood, or other materials. The most reliable, of course, are metal.

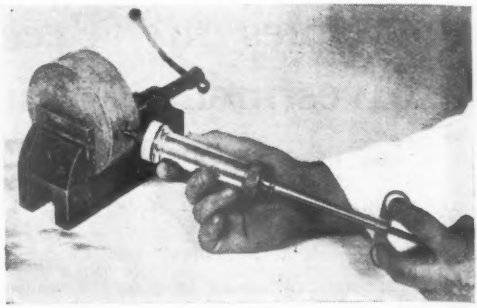

FIG. 3.—MANUALLY-OPERATED SYRINGE FOR INJECTION

2. *Production of the Injection Die.*

There are several ways to make the dies in which the expendable patterns are formed. These dies are the negative shape of the pattern. When making sample castings or checking on the feasibility of making such castings, there are several cheap die materials available. These include rubber, cast stone, and, in some cases, cast metal. If accuracy in dimensions be not required,

FIG. 4.—CENTRIFUGAL CASTING MACHINE AS USED BY DENTISTS.

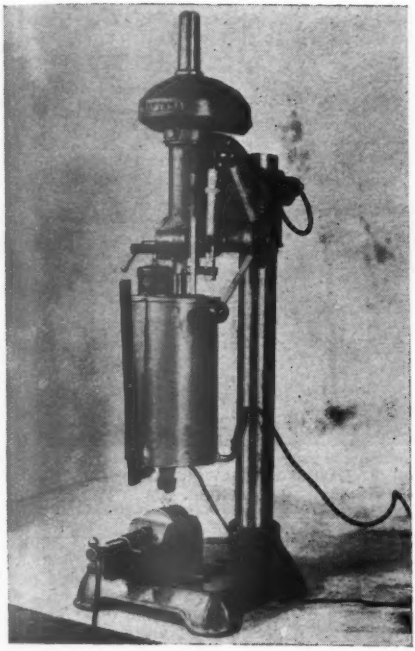

FIG. 5.—LABORATORY TYPE INJECTOR.

the first two may be used since they can be made in a few hours. The cast metal die is capable of considerable accuracy, but will usually wear out after several thousand injections. The steel die is by far the most satisfactory if economically possible, as it will last indefinitely.

Because the soft metal cast die is easy to make and will still give good accuracy, a method to produce one will be described. After the parting line has been decided upon, the master pattern is imbedded in stone or plaster to establish the parting line. It is then dried in a low temperature oven at approximately 125 deg. C. for several hours. A flask is placed over this and the soft metal is poured in. When cold, the stone or plaster is cleaned away and the parting line is trimmed. Another flask is placed on top of the first and a parting compound is applied so that the two halves will not fuse together. The second half is then poured, and when cold, the two halves are separated. It is frequently desirable to apply pressure when casting the die in order to secure complete filling of all the details. This can be done by means of either mechanical pressure or air pressure. It may also be desirable to press the two halves together to cold flow the metal around the patterns. After the two halves are separated, the master patterns are removed and the gates and runners are cut in and the injection hole is drilled. It is desirable to arrange the die so that the gates used for injection are the same as those used for casting. If any pins or cores are to be used they must be fitted in.

3. *Production of the Expendable Pattern.*

As explained in the historical section of this Paper, the early sculptors carved their pieces out of an expendable material; the dentist forced the material into the cavities by hand, the jewellers made a die into which the wax was either poured or forced.

At the present time, two expendable materials enjoy the most usage; wax and plastics. Though many of the treatments also apply to plastics, the Authors prefer to use wax because of the lower injection pressures necessary, because it is easier to control shrinkage, because it melts out at lower temperatures, and wax does not have the danger of cracking the mould through excessive expansion over a long temperature range.

Fig. 1 is a typical thermal expansion curve of a dental casting wax. This curve will apply equally to waxes used in industrial casting, although the numerical values may vary slightly. It will be seen that upon heating the wax expands considerably. Likewise, after injection, the wax shrinks considerably on cooling to room temperature; this is called solid shrinkage. This shrinkage is one of those which must be compensated for when making up the master pattern. In addition, in a complex die there are sure to be distortions, either because

FIG. 6.—GREASE-PUMP TYPE OF INJECTOR.

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certain portions of the die will resist wax shrinkage, or because of variable cooling rates due to the shape cause stresses set up in certain directions.

In addition to the above solid shrinkage, there is liquid shrinkage which manifests itself in dips or depressions in the surface of the wax pattern. This is due to the fact that the centre portions of the wax pattern solidify after the outer walls do, permitting the atmospheric pressure to push in the walls. Fig. 2, left-hand view, shows the wax poured into the die with no added pressure. Note the dips or depressions in the surface. The right-hand picture shows a wax injected at 50,000 lbs. per sq. in. pressure. Note the absence of depressions.

There are three methods by which one can obviate the volume shrinkage. One is to make a "bastard" die and allow for the shrinkage. The second method is to place a piece of solid wax or internal chill in the die to take up the bulk of the space, and thus not allow much liquid wax in the die. The third method is to use very high injection pressures to keep forcing in wax during solidification. Each of these methods has its place and must be used where most practical.

The first method used in filling the die was to pour in the wax. This was perfectly satisfactory until heavy sections were encountered with the subsequent shrinkage problem. The first improvement was the use of the hand or mechanically operated syringe with which possibly 200 to 400 lb. per sq. in. pressure could be obtained (Fig. 3).

The jewellers developed the method of centrifugally casting the wax into the dies, obtaining 25 to 50 lb. per square in. pressure. Fig. 4 shows one of these centrifugal casting machines.

In a majority of the industrial plants the most common method of filling the dies is to force the wax in with air or hydraulic pressure. Fig. 5 shows a iittle device which can be easily built for laboratory or small production work. It is a small grease pump, surrounded by a water jacket, and mounted on a drill press for raising or lowering on to the die. This type of gun will develop pressures of around 1,000 lb. per sq. in.

A unit such as shown in Fig. 6 was used for the production of many millions of turbo supercharger buckets. This unit consists of a vertically mounted

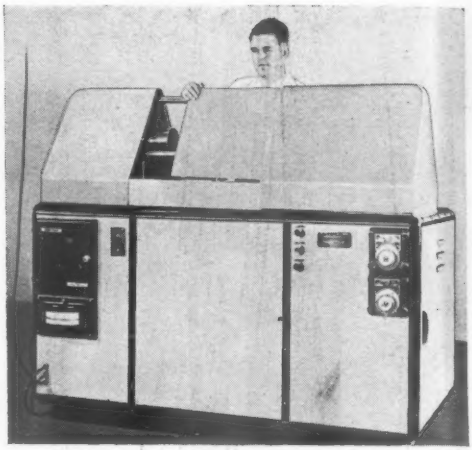

FIG. 8.—HYDRAULICALLY-OPERATED INJECTION MACHINE.

FIG. 7.—INDUSTRIAL WAX INJECTION MACHINE.

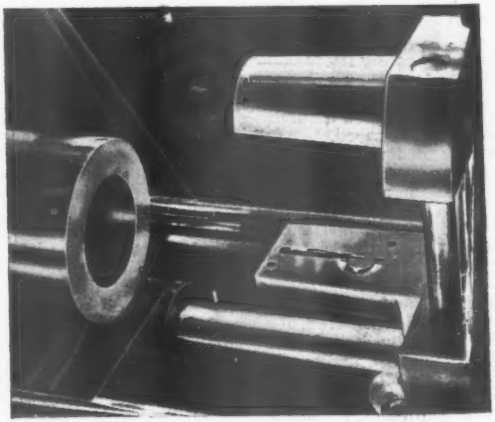

FIG. 9.—DIE HALVES.

FIG. 10.—PATTERN ASSEMBLY.

air cylinder operating on a 1-in. I.D. grease gun. The die was held together in a hold down press and wax was injected at 500 to 1,000 lb. per sq. in. pressure.

Fig. 7 shows a wax injection machine manufactured by an industrial supplier. This machine produces pressures of 8,000 lb. per sq. in. In addition to that, it has automatic hydraulic devices for opening and closing the dies. In this particular arrangement there are six pattern making machines with a central source of heated wax sent under pressure to the dies. The patterns, depending on their size and cooling rate, can be made in this equipment in anywhere from 5 seconds to 1 minute each. As many as 20,000 patterns a day have been made. It has been found, however, that 8,000 lb. per sq. in. is still not a sufficiently high pressure completely to eliminate shrinkage in large pieces.

Fig. 8 shows a machine which has been developed for that purpose. This machine is hydraulically operated, feeding the wax into the die at pressures of as much as 100,000 lb. per sq. in. in large volumes. Five cubic inches of wax per second are automatically injected under a pressure of 1,000 lb. per sq. in. As soon as the die is filled, a special small ram comes into play exerting up to 100,000 lb. per sq. in. pressure on the wax in the die. In order to withstand these pressures, a positive clamping device has to be used. Fig. 9 shows the two tapered halves of the die and the tapered ring into which they fit when closed. This tapered ring provides the positive clamping pressure required.

4. *Assembling of Wax Patterns.*

In order to make the process as economical as possible, the individual wax patterns are grouped together to form an assembly. Fig. 10 shows a typical assembly of turbo supercharger buckets. This grouping serves more than to produce an economical setup, since it has been proved that the more patterns that can be packed into flask and the less investment that is used, the higher the quality of the castings obtained.

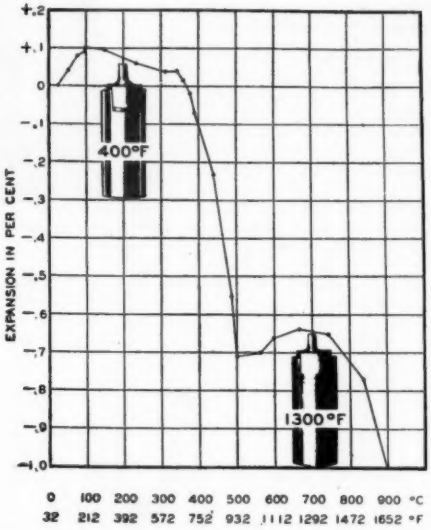

FIG. 11.—THERMAL EXPANSION CURVE, 55 PER CENT. PLASTER OF PARIS INVESTMENT.

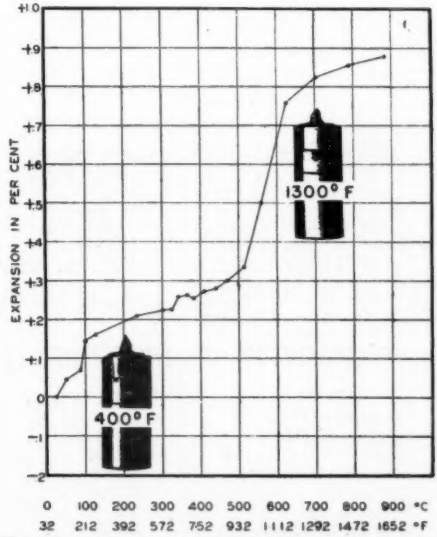

FIG. 12.—THERMAL EXPANSION CURVE, 25 PER CENT. PLASTER OF PARIS INVESTMENT.

Precision Investment Casting

5. *Investing.*

Back in 1907, 1908 and 1909, when the dentists first started making castings, they considered themselves very lucky when they got a casting at all.

They were not at all familiar with investment compounds nor with proper melting and casting techniques, so they did not notice that their inlays did not fit properly until they began to lose teeth As a result, a research commission was established in the U.S. Bureau of Standards to find out why inlays did not fit.

FIG. 14.—DENTAL CASTINGS.

The explanation was the shrinkage chart shown in Fig. 11. Dental investment of that period contained about 55 per cent. plaster of paris as a binding agent. Fig. 11 shows that as the temperature is increased, the investment shrinks until at 900 deg. C. it has shrunk 1 per cent. Add to this the shrinkage occurring in the metal, giving a total of between 2 to 3 per cent. shrinkage. Obviously, the casting would be too small and leakage would occur which would cause decay.

The next step was to make an investment material that did not have so much shrinkage. Fig. 12 shows the expansion curve with investment containing 25 per cent. plaster of paris and the balance a refractory

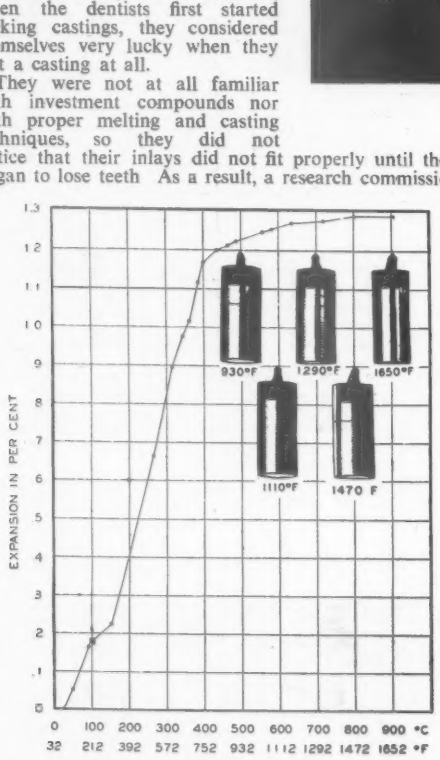

FIG. 13.—THERMAL EXPANSION CURVE—CRISTOBALITE INVESTMENT.

COMPOSITION OF INVESTMENTS

BINDER	REFRACTORY
Plaster of Paris	Quartz
Plaster of Paris	Cristobalite
Tetra Ethyl Silicate	Silica
Alumina Cement	Silica
Zirconium Silicate	Silica
Silica Gel	Silica
Sodium Silicate	Silica

FIG. 15.

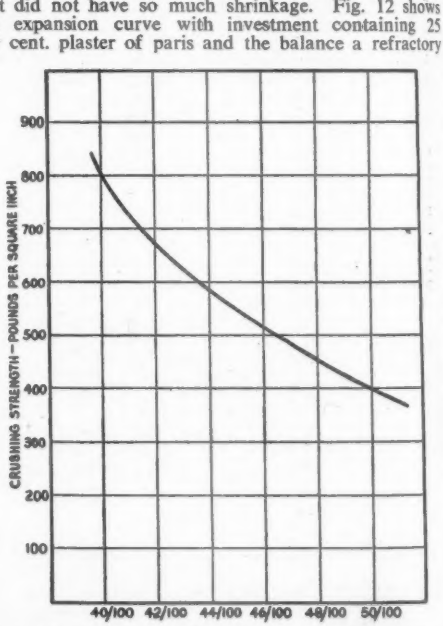

FIG. 16.—INDUSTRIAL CRISTOBALITE-WATER/POWDER RATIO VS. CRUSHING STRENGTH 1 HR. SET.

material. In place of the shrinkage shown in Fig. 11 there is an expansion taking place.

In all modern investments the refractory material is a form of silica. The silica expands, the plaster shrinks, so in order to get higher percentages of expansion, it is necessary to use more silica. This curve, Fig. 12, represents about the maximum that can be expected with quartz, although certain modifiers such as chloride salts can be added to increase the expansion slightly.

In 1932 it was found that by substituting cristobalite for the quartz, an investment having high expansion characteristics could be made. Not only is the expansion high, but it is obtained at the relatively low temperature of 300 deg. C. By this research work the dentists were able to use an investment which would compensate for metal shrinkage and insure an accurate fit of inlays (Fig. 13).

Fig. 14 shows the results obtained in the dental castings. Not only is accuracy necessary, but it can be seen that to maintain the delicate carvings and narrow knife edges, the investment must be easily removed from the casting. Hence, dentistry has contributed three things to the casting process; accuracy, smooth surface, and investment compounds which could be easily removed from the castings.

The modern investments should be divided into two classes: those used for low-temperature work and those used for high-temperature work. Low-temperature investments are used for metal with pouring temperatures of 1,075 deg. C. or below, and which contain no iron. High-temperature investments are primarily used for metals that are poured above 1,075 deg. C., although they may be used for low temperatures also.

Fig. 15 contains a list of binders and refractories. Plaster of paris is the binder used in about 95 per cent. of all the investments used for low-temperature

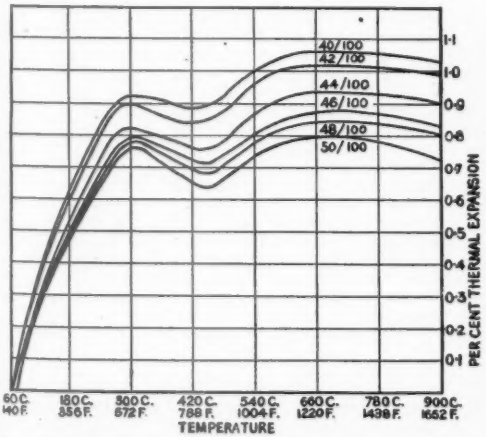

FIG. 17.—INDUSTRIAL CRISTOBALITE EFFECT OF WATER/POWDER RATIO ON THERMAL EXPANSION.

FIG. 18.—DIPPING OF PATTERNS.

casting. The principal binders used in high-temperature investment are silicagel, which may be obtained from tetra-ethyl, silicate, aluminium cement, zirconium silicate, sodium silicate, and various phosphates. The principal refractory is silica, either in the form of

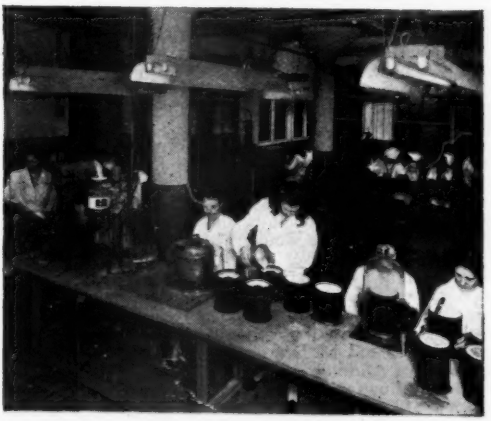

FIG. 19.—QUANTITY PRODUCTION OF PRECISION CASTINGS.

FIG. 20.—VACUUM PROCESSING.

quartz or cristobalite. Other refractories are aluminium oxide, magnesium oxide, or grog. In the use of most investment compounds, they are mixed with either water or some chemical, and then are allowed to set. The first property to be considered is what happens to these materials when the proportions of water or liquid chemical are varied.

Fig. 16 shows properties of a cristobalite investment mixed with water. The ratio of water to powder is plotted horizontally, and it varies from 40 parts water in 100 parts investment to 50 parts water in 100 parts of investment. The crushing strength in lb. per sq. in. is plotted vertically. By changing the ratio from 40 parts of water to 50 parts of water, the crushing strength has been cut in half.

Now, one might have done development work on the castings and used 40 parts of water having a crushing strength of 800 lb. per sq. in. If a centrifugal casting machine was used a force of 550 lb. per sq. in. acting on the fluid metal might be developed. According to Fig. 16 this mixture would withstand that force. If, in production, however, no particular care was taken in measuring the water, the workmen might have used as much as 50 parts of water, thus reducing the crushing strength below that force exerted by the incoming metal. As a result, the mould would crack and the cores break and wash away. This illustrates the importance of retaining a procedure once it is established.

Fig. 17 shows what happened to the expansion curves when the liquid content varies from 40 to 50 parts per 100 parts of investment; that is, the expansion has varied 25 per cent. Hence, in order to maintain tolerances it is very important that the proportioning of the investment be closely controlled.

Three Investment Methods

There are three methods of investing that are commonly applied. Number 1, primary coat and secondary coat, or double investment; number 2, single investment, which is vacuumed and poured; and number 3, single investment which is poured and vibrated.

In the first process a slurry of very finely ground refractories (200 + mesh) and binder is made into which the wax patterns are dipped (Fig. 18). This thin coating is allowed to air-dry after which a coarser slurry is poured into the flask around the coated patterns. In order to assure complete packing, the entire flask is placed in the vibrating table.

The advantage of this process is that a much cheaper secondary investment can be used. The disadvantages are that very small holes cannot be cored out, and that occasionally portions of the dip coat or primary investment peal off, giving a rough surface at that spot and introducing loose foreign material into the mould. Since no vacuum is used it is very essential for the patterns to be arranged in the flask so that no air is entrapped, causing bubbles on the casting.

The second method or the mix, vacuum, and pour method is usually used for very fine detail and when small holes are required, since this is a single investment. The investment is mixed in a relatively low speed mechanical mixer, such as a commercial dough mixer, to avoid beating air into the mix. As soon as the mixing is completed the bowl is covered by a bell jar and vacuum is applied until the air is drawn out of the mixture. The de-aerated investment is then poured into the flask, and, if desired, re-vacuumed to remove any air trapped during the pouring operation. A very smooth pattern is assured by this method, because there will be no air bubbles against the wax pattern to be later converted into nodules of metal when the metal is poured.

Fig. 19 shows this process being done on the production basis. The mixing is shown at the left. The mix is then placed under the bell jar and vacuumed. It is then poured and allowed to stand until set. Fig. 20 shows the air bubbles rising out of the mix during the vacuuming process.

The third method of investing also employs a single type investment, but is used in a much thicker consistency than is used in a mixed, vacuum, and pour method, hence, in order to ensure a good pack, it is necessary to vibrate the flask containing the investment. Little more need be said about this type of investment.

(*To be continued.*)

An Apology

ON OUR RETURN from holidays, we noticed that in our leading article of June 26, Mr. D. Howard Wood's name was printed as Mr. D. Howard Webb. We sincerely regret this unfortunate misprint.

Preparation of Foundry Sands for Market

*By F. G. Goettman**

Sand deposits are the disintegration products of various rocks and have been formed in a number of ways. They may be residual or transported greater or lesser distances by water, wind or ice. The composition, shape, size and uniformity of the sand grains within a given deposit are dependent on the origin and history of the deposit and these properties can be changed only within certain limits.

In developing a sand deposit, test holes and/or pits are sunk in some ordered manner, usually at the corners of a square grid. These test holes are plotted on a map of suitable scale as are test data obtained from laboratory analyses of the borings. From this map, cross sections through the deposit can be drawn, showing the location and the arrangement of the various types of sands and the overburden.

From the map and cross-sections, the amount of overburden and quantity of the grades of sand can be computed and, if the deposit warrants development, a suitable mining and processing method can be formulated.

The foundry industry's sand requirements can be classified as follows: Bonded sands or those containing more than 5 per cent. clay; semi-bonded (sometimes referred to as bank sands) containing up to 5 per cent. clay; washed sands.

Bonded and Bank Sands

Bonded and semi-bonded or bank sands are characterised by sand grains naturally bonded with clay. Many varieties are mined but the predominant components are silica grains and one or more clay minerals. These grades are usually found in the younger geologic formations. Those suitable for foundry use must contain the proper qualities of grain size, refractoriness, bond, permeability and durability.

Bonded and bank sands of foundry quality are not as widespread as the geologic origin would indicate. The preparation of bonded sands for market varies according to the geology of the deposit, the amount of deleterious material present and the type of grade of sand desired and can best be discussed by describing typical examples such as the Albany N. Y. and southern New Jersey districts.

The Albany sands are located in a narrow belt along the Hudson River extending from the Adirondacks southward about one hundred miles into Dutchess County and are of glacial origin. The glaciers coming from the north eroded the areas they passed over and, by constant attrition, ground most of the rock fragments to sand, eventually mixing them with shales and clay gathered along their course.

As the glaciers melted, the water deposited the sediment over a large area. Subsequently, these deposits were subjected to weathering which resulted in the decomposition of the shale fragments to form the bond and alterations of the iron minerals to the hydrated form giving the characteristic brown colour to the sands.

The amount of overburden or topsoil ranges from 6 to 18 in. and the sand deposits vary from 12 in. to 4 ft. As is typical of glacial deposits, the material is not uniform and only scattered deposits are suitable for foundry use.

Stripping the Overburden

The deposits that are suitable for foundry use are developed by stripping the overburden from a narrow section about 6 ft. in width and the length of the particular deposit. These strips are usually cut parallel to a property line and, after mining of the sand, the overburden from the next section is removed and spread over the mined area and the field is left in suitable condition for farming.

After stripping, the sand is carefully examined and sampled. From laboratory test data, the sand is classified as to grade or grades. The sand is then mixed under the supervision of an experienced foreman, loaded on trucks and hauled to the railroad siding.

Here it is put through a rotary screen which is mounted on a truck chassis and powered by a petrol motor. The screen discharges to an inclined belt which throws the sand into the railway wagon or lorry.

Albany sands are designated by number and range from 000, the finest, to 4, the coarsest. A tabulation of the number and equivalent average fineness is shown in Table I. With such a large variety of sands more data, such as clay content, strength and permeability are required to specify a sand.

TABLE I—*Designation of Albany Sands based on approximate A.F.A. Average Fineness Numbers.*

Grade	Mild	Medium	Strong	Extra Strong
000	—	260	270	280
00	205	225	245	260
0	185	205	225	245
01	160	185	190	215
1	140	160	170	190
1½	120	140	150	170
2	100	115	125	150
2½	75	90	105	120
3	65	75	90	100
4	55	65	75	—

Although one deposit may contain several grades, many deposits must be developed so that any grade can be mined when required. Since these deposits are scattered over a large area, portable mining and processing equipment is the most practical.

* A paper presented to the 1947 Conference of the American Foundrymen's Association.

The sands of southern New Jersey originated from the erosion of older formations—some are marine deposits while others are terrestrial.[2] The deposits are stratified and a formation can readily be traced. This does not mean, however, that the sand deposits are uniform, as numerous test holes must be sunk to find a deposit of suitable grade.

The overburden ranges from 3 to 6 ft. and the deposits of sand range from 8 to 60 ft. in thickness, several grades being found in the same section. At Millville, N.J., the overburden is removed by scraper wagons and bulldozers. High banks of sand are mined with a one-yard shovel handling a 1¼ yard bucket. In thinner banks, or where greater selection is required, a ⅜-yard truck shovel is used.

The material is hauled by trucks from the pit to the processing plant where it is passed through a 10 by 25 ft. rotary screen and discharged to a 450 ft. belt conveyor, 300 ft. of which is structurally supported 35 ft. from the ground. The sand is then tripped off the conveyor into the proper storage pile. A 60-ft. portable conveyor is used so that piles can be stored to either side of the main conveyor. Nine basic sands are mined in as many pits and are stored under or to the side of the conveyor.

From the drilling record and close observation by the foreman, lenses and pockets of off-grade material are deleted and separately removed and used for fill or dumped with the stripping. Samples are taken to the laboratory for analysis during the daily production and if the material is not up to specification it is removed from storage.

Despite such precautions, material due directly from the bank is apt to, and invariably does, vary as to strength and grain size. The storage piles effectively blend these variations and when the material is loaded from these piles it is a homogeneous mixture whose characteristics have been predetermined by laboratory analyses.

One of the nine basic sands which range in average fineness from 30 to 110 and in clay content from 2 to 25 per cent. will meet the specifications for many uses. In addition, by blending one or more of these basic sands with or without clay, a sand can be prepared which will meet practically any specification.

The blending of sands is accomplished by using a 3-compartment, 110-ton bin from which batches are accurately weighed and fed to a 15-cub. ft. speedmuller. This discharges on to a 60-ft. portable conveyor which feeds the sand into cars or trucks.

By careful prospecting and mining, followed by screening and accurate blending, high-grade moulding sands are produced. However, the importance of maintaining experienced field foremen and constant laboratory analysis cannot be over-emphasised.

Washed Sands

Washed sands derive their name from the process of preparation. The deposits suitable to production are those sufficiently large to warrant the expenditure for a plant. Such deposits must contain the proper sizes and composition of grain, and must be low enough in clay content to be readily washed clean.

Assuming that the deposit is satisfactory in all respects, the main problem relative to production is the design and layout of a plant which will produce grades that are currently required and yet be flexible to changing markets. The general practice is to mine hydraulically and classify the sand. This may be supplemented with screening in some instances. A typical example is the operation at Manumuskin, N.J.

This deposit averages 50 ft. in depth, 40 ft. of which is below water level, and contains over 98 per cent. silica grains, approximately 1 per cent. clay, and a small percentage of heavy minerals. The 2½ to 3 ft. of overburden is removed by a diesel engine powered tractor with a 5 cub. yd. scraper wagon.

The mining is accomplished by a 6-in. centrifugal pump powered by a 100-h.p. electric motor and having an 8-in. discharge. The slurry, averaging 15 per cent. solids by weight, is pumped about 1,000 ft. to the plant at the rate of 1,200 to 1,500 galls. per min. or an average of 50 tons of sand per hr. It is then discharged into a storage box from which it flows into a revolving screen which scalps off the plus six mesh materials which are discharged *via* a steel pipe from the plant.

The sand and water pass into a settling box of proper dimensions to settle plus 140 mesh grain. The overflow from this tank is passed back to a reservoir and the sand is drawn from the bottom and pumped to an overhead tank which feeds four classifiers. The classifiers use a water current of adjustable speed to produce a sand of one particular fineness.

Classifying the Sand

By regulating the feed and the classifiers, production of each grade is kept uniform. The first classifier produces a sand with an average fineness of 27, the second 35, the third 45, and the fourth 68. The discharge from the classifiers is pumped to dewatering towers and ground stored for drainage to about 3½ per cent. moisture before shipment as damp sand.

The discharge from the first classifier is sent to the dry plant where it passes through a 6 by 33 ft. oil-fired dryer which revolves at 7 r.p.m. The dry sand is discharged on to a screw conveyor to a bucket elevator which carries it up to a combination of double deck vibrating screens. These divide the sand into the following four sandblast sizes which are stored in four 800-ton concrete silos:—

6 to 10 mesh or No. 3 sandblast sand.
10 to 14 mesh or No. 2 sandblast sand.
14 to 24 mesh or No. 1 sandblast sand.
Minus 24 mesh or No. 0 sandblast sand.

Any grade of sand produced by the wash plant can be passed through the dryer and conveyed directly into cars, thus eliminating the necessity of dry storage of these grades.

The important factors in the production of uniform washed sands have been described and may be summarised as:—

(1) Thorough removal of overburden; (2) control of feed to the classifiers; (3) adjustment of classifiers; (4) extensive use of screen analyses and other laboratory tests.

Centrifugal Casting of Copper Alloy Wheels in Sand Moulds

Dr. A. R. J. Lee and Dr. L. Northcott recently published an interesting Paper in the Journal of the Institute of Metals, Vol. 73. The following synopsis has been prepared, due to the value of this Paper to foundrymen.

Wheel castings (10 in. dia.) of five copper-base alloys made in static sand moulds are compared with sand castings prepared in a vertical-axis centrifugal casting machine in which the casting conditions were varied, the main variables being rotational speed and casting temperature. It was found that the cross-sectional area of the arms of the wheel had a marked effect on the soundness of the castings and variations in arm thickness were also made. The castings were sectioned and etched to obtain information on soundness and structure and tensile tests were made on samples cut from different positions. The alloys examined were a 10 per cent. aluminium bronze containing 5 per cent. each of nickel and iron, a high-tensile brass, a gun-metal, a leaded gun-metal, and a phosphor-bronze.

Under the optimum casting conditions, centrifugal casting improved the strength of samples cut from the wheels by from 3 per cent. in the high-tensile brass to 35 per cent. in the phosphor-bronze; elongation values were also improved. The effects of centrifuging on chemical segregation were investigated but, although segregation was detected, it was only in the leaded gun-metal that segregation (of lead) was appreciable.

Static and Centrifugal Conditions Compared

The Authors arrived at the following conclusions:—

In attempting to generalise from the data presented on wheel castings, it should be borne in mind that a design of casting which can be obtained almost sound by static casting without feeder heads will only require a fairly small pressure (*i.e.*, speed of rotation) to make it sound as a centrifugal casting. Conversely, a casting in which directional solidification towards the central runner is impossible will not prove capable of improvement by centrifugal casting at any practicable speed. In the wheel type of casting, the minimum ratio of arm cross-section to rim volume of 1:10 found for light alloy castings would seem to be a rough basis for design calculations in copper-base alloys also, although if this ratio were considerably exceeded, lower speeds of rotation might be possible. Two main types of alloy have been investigated. The type with a narrow freezing range (aluminium bronze and high-tensile brass) is not so suitable for centrifugal casting in sand moulds as the type with a wide freezing range (gun-metals and phosphor-bronze).

In the aluminium bronze and high-tensile brass types of alloy, a high speed of rotation during casting should be employed and no metallurgical defects due to segregation or separation of constituents are to be expected. Improvements in mechanical properties of the castings up to the values obtained from static cast test-bars may be expected, but this will not normally represent much improvement over a similar static casting, except possibly at one or two special positions in the casting.

In the tin-bronze alloys, centrifugal castings have considerably improved properties over static castings because the latter invariably contain dispersed porosity. This porosity may be due to shrinkage or gas, or both. The greatest improvement in properties was obtained with the phosphor-bronze because the metal/mould reaction produces gas-porosity and results in static castings having a low density. Centrifugal pressure increases the density markedly and more rapidly than is explainable by a simple compression effect. There is thus no reason why the properties of centrifugal castings should not exceed those of a normal static test-bar. Because of the degassing procedure employed, the gun-metals should not have contained any gas porosity and there was therefore less room for improving the soundness by centrifugal casting. For gun-metal not degassed, the superiority of centrifugal castings would be greater than in the present tests. Owing to the fact that static gun-metal test-bars contain some dispersed porosity, there is no *a priori* reason why centrifugal castings should not have better properties than static test-bars. Although centrifugal castings are denser the higher the speed of rotation, tensile properties do not improve continuously with speed of rotation. The distribution of eutectoid in the microstructure appears to be adversely affected by centrifugal casting and the best mechanical properties are obtained at moderate speeds of rotation. Annealing of centrifugal tin-bronze castings to dissolve the eutectoid results in greater improvement in mechanical properties than in static castings, and the improvement is greatest at the highest speeds of rotation. Leaded gun-metals suffer only slight segregation of lead in centrifugal casting, but annealing has less benefit in these alloys.

In this work, no account has been taken of the economic advantages of centrifugal casting and the greater uniformity of the product, which together might be sufficient to recommend the process even in the absence of significant improvements in the properties of the castings.

Subscriptions for the Institute of Metals

The Institute of Metals has issued the following statement showing the revised annual membership subscriptions with effect from July 1, 1947:—Ordinary members £4 4s., associate members £1 15s., and student members £1 1s. Joint membership with the Iron and Steel Institute and/or the Institution of Metallurgists:—Ordinary members £3 13s. 6d., associate members £1 11s., and student members £1 11s.

EVERY YOUNG MAN entering the services of a jobbing foundry as a traveller is instructed to get hold of the actual patterns for the purpose of quoting, as the *patron* usually considers that this is well on the way to securing an order. In the U.S.A. a patternmaking concern, City Pattern Foundry & Machine Company, Detroit, has gone a step further and equipped its delivery vans with a mobile telephone service.

Wasters due to Core Reinforcements

By "Coroner"

The use of iron wire or cast-iron grids for core reinforcement depends largely on the job. Whereas for most jobs the particular medium is easily determined, occasionally cases occur where it is rather difficult to decide which to use. One important consideration to be borne in mind when making a decision on a border-line case, is to ensure that the core is easily vented and no restriction is offered to the free exit of gases.

A particular example, shown below, is a part section of a colliery winding drum. The job was cast in the position shown with joints in the mould at A and B. The lightening core C was placed in the mould on studs D, as the lower part was required solid, the core being vented through six holes of considerable area in the top at E, the vents being lead through the top box at F.

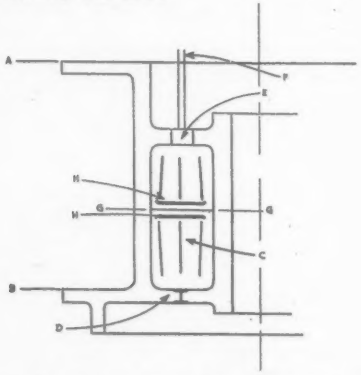

FIG. 1.—WINDING DRUM CASTING.

Similarly designed castings of different size had been produced satisfactorily previously, but this particular model gave trouble. Wasters occurred through blowing, which resulted in a defective top flange. The runner system was examined together with the method of sealing the core vents, but no clue could be discovered for the cause of the trouble.

Ultimately it was decided to break a core, which was made in two halves jointed at GG, and examine the venting system. This revealed that the lower part of the core was practically isolated from the top half by the two core grids HH and thus made it almost impossible for any of the gases in their lower part to reach the vent, thereby accounting for the blowing. Discarding the cast-iron grids and using stiff core wire resulted in trouble-free castings, although this type of reinforcement took a little longer to prepare.

Jointing Patterns

By "Chip"

Patterns are the means whereby the foundryman produces moulds, and they should therefore always be constructed to favour the easiest method of moulding. For this reason, it is often necessary to joint a pattern in halves to allow of the more rapid production of moulds, but this method is not always ideal, and a word with the moulder before the pattern is commenced is often wise.

For example, a casting, as below, when required in quantities, would be machine moulded from two half patterns, but for a one-off job, or occasionally required castings, a solid pattern should be supplied rather than one jointed in halves. There are several reasons for this, one being that the pattern is stronger and not so liable to distort as the more flimsy construction in halves, but the main reason is that of moulding technique.

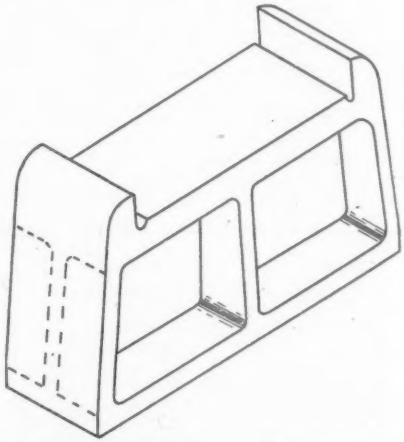

FIG. 1.—CASTING CAPABLE OF TWO TREATMENTS.

When moulding from a pattern jointed in halves, it is necessary to carry a considerable portion of the mould in the top box and this requires reinforcement in the form of lifters, etc. When, however, the pattern is made in one piece, the major portion of the mould in the top, and thus allows of a much shallower top is in the bottom box and only the minimum is lifted box being used and far less lifters.

S. and W. Magazine for July. Issued by Smith & Wellstood, Limited, Bonnybridge, Scotland. This eight-page magazine is written for the benefit of the staff. It is a well balanced, nicely illustrated production, which should do much to cultivate an esprit de corps amongst the personnel.

Wider Use of Double Day-shifts

The view that wider use of the double day-shift system in industry would make an important contribution to the economic well-being of the country is expressed in the report published recently of the Committee which was set up in 1945 by Mr. Ernest Bevin to consider the problem. The Committee did not concern itself primarily with the "staggering" of hours to relieve the load on generating plant.

The Minister of Labour has stated in the House of Commons that the Government agree with the view taken in the report that, if we are to maintain and improve our standard of living without widespread increases in the working hours of individuals, there will have to be much more double day-shift working. They also agree, he said, with the Committee that the workers will not accept the system unless they are convinced that i.s social inconveniences to themselves can and will be offset as far as possible by compensating benefits. The more people there are working on the system in any area, the less the social disadvantages will tend to be; and the Government endorse the view of the Committee that every effort should be made to adjust social and educational services to meet the needs of double day-shift workers.

Mr. Isaacs said that at present, with certain special exceptions, shift working by workers other than adult males is prohibited by the Factory Acts unless it is specially authorised by the Minister of Labour and National Service for a particular factory. It is, therefore, necessary to consider how the Factory Acts could be modified so that they do not hamper industrial planning of production on a two-shift basis, or hinder the progressive recognition of shift working as a normal arrangement. The Government are not satisfied that it is necessary to retain in full the present legal obstacles to the adoption of the double day-shift system, provided, of course, that adequate power is retained to ensure that proper protection is afforded for the health and welfare of persons employed on the system. The Government accordingly propose to consult the National Joint Advisory Council on this matter and also on the question of the morning and evening time limits within which the system should be made legal. He said that the latter point is important because the economic advan ages of double day-shift working are derived, in the main, from the longer hours for which plant can be worked.

ADDRESSING MEMBERS OF the British Engineers' Association at Glasgow, last week, Mr. Arthur Woodburn, M.P., Parliamentary Secretary to the Ministry of Supply, spoke of the tremendous achievements of the engineering industry in the drive to increase exports. Last year, he said, the industry contributed £300,000,000 in exports out of a total of over £900,000,000. Towards the end of the year this figure was rising to a rate of over £400,000,000 a year, or 37 per cent. of the total visible exports of the country. This was 62 per cent. more than the 1938 figure.

Richard Thomas & Baldwins' Developments

Referring to the Steel Company of Wales project, Mr. E. H. Lever, chairman of Richard Thomas & Baldwins, Limited, in his statement accompanying the annual accounts, says that the cost of the new construction on the basis of present prices will be of the order of £60,000,000, and negotiations for the provision of finance from outside sources estimated to be sufficient, with the new company's own resources, to enable the programme to be carried out are very near completion. The physical assets to be transferred to the new company by Richard Thomas & Baldwins consist of substantially all their old-type tinplate works. The net effect of this development, therefore, so far as they are concerned, is that they will be exchanging the direct ownership of these old-type works for shares in a company owning a wide range of assets and possessing in due course the most modern strip mills in the country. Mr. Lever says that the project is so vast and so complex that it would be idle to pretend that all problems have been solved and all details worked out, but a great step forward has been taken, and with the goodwill of all parties concerned they are looking forward confidently to the complete success of what is probably the biggest single contribution to the economic recovery of the country.

"In addition to this major development, we envisage the expenditure of substantial capital sums over the next few years for expansion and for further modernisation at Ebbw Vale, Redbourn, Panteg, and elsewhere. We expect to be able to finance all these developments, including our contribution to the Steel Company of Wales from present or anticipated internal resources. We do not expect therefore that it will be necessary to raise for these purposes any new share or loan capital for Richard Thomas & Baldwins," the chairman continues.

On the subject of nationalisation he says that they are not yet aware of the Government's proposals concerning the future of the iron and steel industry, nor do they know when they are likely to be carried into effect. Uncertainty in this respect is naturally a considerable handicap, but while responsibility remains in present hands the clear duty of the industry is to press ahead with its plans and not to do anything to retard national recovery.

THE LOCOMOTIVE DIVISION of Ruston & Hornsby, Limited, Lincoln, have orders on their books at the present time which aggregate more than 400 machines of various types. A large proportion is for export and the orders from abroad include machines for coal, gold and ironstone mines, petroleum refineries, banana plantations, public works contracts and other diverse duties. For home use a considerable proportion of the smaller locomotives is on order for coal mines, Scottish hydro-electric schemes, and peat development in Eire, while the company's oil-engined shunting locomotive programme includes machines in gasworks, electricity stations, harbours, steelworks, and chemical plants

Pig-iron and Steel Production in Great Britain

The following particulars relating to pig-iron and steel production in Great Britain have been extracted from the Statistical Bulletin for June, 1947, issued by the British Iron and Steel Federation. Table I gives the production of pig-iron and ferro-alloys in May, with the number of furnaces in blast at the end of the month; Table II, production of steel ingots and castings in May; and Table III, deliveries of alloy and non-alloy finished steel. Table IV summarises the activities of the steel industry as a whole during the six months ended May, 1947.

TABLE I.—*Weekly Average Production of Pig-iron and Blast-furnace Ferro-alloys in May*, 1947. (*Thousands of Tons.*)

District.	Furnaces in blast, 31.5.47	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts, Northants, and Essex	23	—	12.8	18.4	1.6	—	32.8
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Ches. / Yorkshire (incl. Sheffield, excl. N.E. Coast)	6	—	6.5	—	—	0.8	7.3
Lincolnshire	11	—	19.8	—	—	—	19.8
North-East Coast	22	5.4	27.0	0.7	—	1.3	34.4
Scotland	8	0.6	7.8	2.4	—	—	10.8
Staffs., Shrops., Worcs. and Warwick	5	—	4.4	0.3	—	—	4.7
S. Wales and Monmouthshire	7	0.1	19.6	—	—	—	19.7
North-West Coast	6	11.4	—	0.5	—	0.5	12.4
Total	88	17.5	97.9	22.3	1.6	2.6	141.9
April, 1947	90	18.4	94.5	22.2	1.4	2.7	139.2
May, 1946	97	22.2	105.1	20.2	1.0	2.7	151.2

TABLE III.—*Weekly Average Deliveries of Non-alloy and Alloy Finished Steel.* (*Thousands of Tons.*)

Product.	1946.	1947 (1st 5 months).	1946. May.	1947. April.	1947. May.
Non-alloy Steel:—					
Heavy rails and sleepers	9.0	7.2	10.9	6.5	7.5
Heavy and med. plates	30.9	29.5	32.8	32.1	31.7
Other heavy products	31.9	31.1	33.4	34.6	34.5
Light rolled products (excl. wire rods and alloy-steel bars)	48.9	47.9	53.5	50.5	49.6
Ferro-concrete bars	3.2	2.8	4.1	3.6	3.1
Cold-rolled strip	4.2	4.5	4.2	4.7	4.6
Bright steel bars	4.5	4.4	4.8	4.7	5.0
Sheets, coated and uncoated	22.4	24.2	24.0	25.8	25.5
Tin, terne and black-plate	10.4	11.8	10.2	12 3	12.0
Tubes and pipes	14.0	12.5	14.7	14.2	13.1
Steel wire	11.8	10.5	12.5	11.1	11.3
Tyres, wheels and axles	3.4	3.3	3.5	3.5	3.2
Forgings	4.9	4.7	4.9	4.9	4.7
Castings	2.9	2.8	3.0	2.8	3.1
Total	202.4	197.2	216.5	211.3	208.7
Alloy Steel:—*					
Plates	0.3	—	0.3	—	—
Tubes and pipes	0.2	0.3	0.2	0.3	0.3
Bars, sheets, strip and wire	2.9	3.4	3.0	3.8	3.8
Forgings	3.6	1.5	1.5	1.7	1.5
Castings	0.6	0.6	0.6	0.6	0.7
Total	5.6	5.8	5.6	6.4	6.3
Total production†	208.0	203.0	222.1	217.7	215.0
Less Intra-industry conversion	16.4	15.2	18.7	17.9	17.2
Net U.K. deliveries	191.6	187.8	203.4	199.8	197.8
Add Deliveries of imported finished steel	—	—	—	—	—
Total finished steel	191.6	187.8	203.4	199.8	197.8

* Excludes high-speed steel.
† Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.

TABLE II.—*Weekly Average Production of Steel Ingots and Castings, May*, 1947. (*Thousands of Tons.*)

District.	Open-hearth. Acid.	Open-hearth. Basic.	Bessemer.	Electric.	All other.	Total.* Ingots.	Total.* Castings.	Total ingots and castings.
Derby, Leics., Notts., Northants and Essex	—	—	(Basic) 7.6	0.9	0.3	8.4	0.4	8.8
Lancs. (excl. N.W. Coast), Denbigh, Flint. and Ches. / Yorkshire (excl. N.E. Coast) and Sheffield	0.7	20.7	—	0.4	0.4	21.4	0.8	22.2
Lincolnshire	—	22.6	—	—	0.1	22.6	0.1	22.7
North-East Coast	3.0	47.1	—	0.6	0.4	49.9	1.2	51.1
Scotland	4.2	30.9	—	1.3	0.6	35.5	1.5	37.0
Staffs., Shrops., Worcs. and Warwick	—	12.1	—	0.5	0.6	12.2	1.0	13.2
S. Wales and Monmouthshire	6.6	37.6	(Basic) 4.1	0.7	0.1	48.8	0.3	49.1
Sheffield	7.2	19.4	—	6.4	0.5	32.0	1.5	33.5
North-West Coast	0.4	2.2	(Acid) 3.6	—	0.1	6.2	0.1	6.3
Total	22.1	192.6	15.3	10.8	3.1	237.0	6.9	243.9
April 1947	21.7	185.9	15.2	10.6	3.0	229.6	6.8	236.4
May, 1946	26.6	203.2	19.7	9.3	3.0	254.9	6.9	261.8

* Including alloy steel.

(*Continued at foot of facing page.*)

Personal

MR. A. G. GUTHRIE has resigned from the board of J. & E. Hall, Limited, engineers and ironfounders, of Dartford.

MR. F. A. J. HODGES, shipyard manager of John Readhead & Sons, Limited, South Shields, has been appointed general manager of the company.

MR. HUGH HENDERSON, a director of the Appleby-Frodingham Steel Company, Limited, is the new chairman of the Foamed Slag Producers' Federation.

MR. WALTER BONSACK, of Cleveland, has been elected chairman for 1947-49 of the aluminium and magnesium division of the American Foundrymen's Association.

SIR CLAUDE GIBB, a director of C. A. Parsons & Company, Limited, engineers, turbine makers, etc., of Newcastle-upon-Tyne, has received an honorary degree from Durham University.

MR. FRANCIS A. FOX, formerly chief metallurgist with Magnesium Elektron, Limited, Clifton Junction, near Manchester, and now with the British Welding Research Association, has been awarded his D.Sc. at Birmingham University.

MR. J. MITCHELL has been appointed chairman of Mitchell, Shackleton & Company, Limited, manufacturers of steel forgings, etc., of Patricroft, Lancs., in place of the late Mr. E. Shackleton. MR. J. A. CLARKE has been appointed a director in place of the late Mr. E. Oakden.

MR. E. W. COLBECK has now taken up his appointment as metallurgical and research director of Hadfields, Limited. During the war he acted as consultant to various ordnance factories and more recently has been intimately concerned with developments carried out by the Department of Atomic Energy of the Ministry of Supply.

SIR FREDERICK LEGGETT has been appointed chairman of the London and South Eastern Regional Board for Industry. He was chief adviser on industrial relations to the Ministry of Labour and later became chief industrial commissioner. He was the British Government representative and member of the governing body of the International Labour Office and was chairman of that body from 1936-37.

Membership and Functions of Planning Board

The membership of the Economic Planning Board was announced in the House of Commons last week by Mr. Herbert Morrison, Lord President of the Council, who also outlined the scope of the Board's functions. The Board will be under the chairmanship of Sir Edwin Plowden, Chief Planning Officer, although Mr. Morrison intimated that he might on occasions take the chair himself.

The other members of the Board are:—Sir William Coates (a deputy chairman of Imperial Chemical Industries, Limited); Sir Graham Cunningham (chairman and managing director, Triplex Safety Glass Company, Limited); Mr. W. R. Verdon Smith (a director of Bristol Aeroplane Company, Limited); Mr. A. Naesmith (secretary of Amalgamated Weavers' Association); Mr. J. Tanner (president of the Amalgamated Engineering Union); Mr. H. V. Tewson (general secretary of the T.U.C.); Sir Godfrey Ince (Permanent Secretary, Ministry of Labour); Sir John Woods (Permanent Secretary, Board of Trade); Sir Archibald Rowlands (Permanent Secretary, Ministry of Supply); Mr. H. T. Weeks (Central Economic Planning Staff); Mr. F. W. Smith (Central Economic Planning Staff); Mr. A. S. Le Maitre (Central Economic Planning Staff), and Mr. R. L. Hall (Director of the Economic Section Cabinet Office).

Mr. Morrison said that the primary task of the Board would be to advise the Government on the best use of our economic resources both for the realisation of a long-term plan and for remedial measures against our immediate difficulties. Close co-operation and consultation between the Government and industry would be possible under these arrangements, which were in addition to and not instead of the arrangements for close consultation already maintained between industry and Government departments.

THE TRADE STATISTICS for February last, issued by the Eire Department of Industry and Commerce, state that imports of iron and steel totalled 666 tons, valued at £19,398, against 1,720 tons and £35,365 in the corresponding month of last year.

PIG-IRON AND STEEL PRODUCTION IN GREAT BRITAIN (*Continued from facing page.*)

TABLE IV.—*General Summary of Pig-iron and Steel Industry.* (*Weekly Averages in Thousands of Tons.*)

Period.	Iron ore output.	Imported ore consumed.	Output of pig-iron and ferro-alloys.	Scrap used in steel-making.	Steel (incl. alloy).			Steel stocks held by producers, etc.*
					Steel imports.	Output of ingots and castings.	Deliveries of finished steel.	
1938	228.1	89.2	130.0	117.9	16.2	200.0	—	—
1946	234.1	115.4	149.3	147.0	8.3	244.1	191.6	1,189.7
1946—December	216.7	125.7	153.2	143.3	4.9	236.3	185.8	1,045.3
1947—January	218.0	127.4	150.1	144.5	5.1	239.8	196.0	1,067.5
February	146.4	116.1	126.1	122.7	10.1	206.2	161.2	1,000.5
March	172.1	111.0	123.1	117.7	12.7	196.0	179.2	983.2
April	207.9	122.1	139.2	144.9	9.3	236.4	199.8	915.4
May	213.9	124.0	141.9	149.3	12.3	243.9	197.8	870.6

* Stocks at the beginning of the years and months shown

News in Brief

THERMOTANK, LIMITED, Glasgow, have started production at their new factory at Jarrow.

THE 5 PER CENT. redeemable debenture stock of the Rio Tinto Company, Limited, will be repaid at par on October 1 next.

SIR ARCHIBALD FORBES, chairman of the Iron and Steel Board, recently visited the works of the Park Gate Iron & Steel Company, Limited, Rotherham.

CROMPTON & HARRISONS, LIMITED, shiprepairers and structural and welding engineers, of Seaham Harbour, Co. Durham, are to carry out additions to their factory.

PLANS HAVE BEEN APPROVED for the erection of a patternshop at the works of John Readhead & Sons, Limited, shipbuilders, engineers, etc., of South Shields.

WALMSLEYS (BURY), LIMITED, manufacturers of paper-making machinery, etc., have acquired the whole of the share capital of John Wood & Sons, Limited, colliery engineers and ironfounders, of Wigan.

THE S.S. CANDINA, carrying 4,000 tons of rubio ore, arrived in the Tees recently, thus marking the revival of an old trade between Spain and Middlesbrough. The war caused the trade to lapse almost entirely.

A NEW BRITISH STANDARD SPECIFICATION for screwed and socketed steel tubes and tubulars will shortly be issued, which is being given the number 1387 and will replace B.S. 789-1938 and B.S. 789A—War Emergency Revision, 1940.

THE FIRST MEETING of the Council of the International Organisation for Standardisation since the ratification of its constitution was held in Zurich last month. An extensive programme of technical work will be submitted to the standards organisations in the different countries for consideration.

THE OUZLEDALE FOUNDRY COMPANY, LIMITED, Barnoldswick, Colne, Lancs, are opening up a new foundry near Long Ing Shed later in the year. Shower baths and changing rooms are to be provided. The new building should treble the company's output, which mainly consists of fire grates and builders' requisites.

IT IS UNDERSTOOD that the Iron and Steel Board have given approval to Firth-Vickers Stainless Steels, Limited, Sheffield, for the erection of a new plant for the production of stainless-steel sheets and strip near to their Staybrite Works at Tinsley. The new plant will cost more than £1,000,000. It will more than double the company's present output of stainless-steel sheets.

HADFIELDS, LIMITED, Sheffield, responding to requests from their employees for exhibitions of their film, "The Production of High-quality Steel," to which they, together with their wives and friends, could be invited, have rented a cinema at Attercliffe for a series of private shows, the demand for seats proving to be beyond the capacity of the company's own theatre.

SIR IAN STEWART-RICHARDSON, chairman of Sydney S. Bird & Sons, Limited, manufacturers of condensers, of Enfield, says in his annual statement that it is proposed to offer the remaining £10,000 of unissued shares to shareholders in the near future. The company has recently been handicapped by lack of manufacturing space, and plans have been submitted for extensions to the main works.

SPEAKING AT THE annual general meeting of the British Non-ferrous Metals Federation, Mr. Horace W. Clarke, who was re-elected president, said that the Federation would shortly be making representations to the Government stating that the industry was concerned about the continuance of bulk-purchasing, and considered that the time was approaching when the ban might be lifted from the London Metal Exchange, although before that was done the industry would wish to be assured of adequate safeguards to prevent undue speculation, and the exploitation of the consumer.

IN ORDER TO finance the acquisition from the Government of plant and buildings now in use by subsidiaries and to meet trading expansion, the board of Birmid Industries, Limited, intend offering 274,000 ordinary £1 shares to shareholders at 70s. each on the basis of two for five. Net proceeds will be £943,000, subject to any bonus tax payable. The expenditure programme calls for £1,175,000. Authorised capital is to be doubled to £1,500,000. The company controls the Birmingham Aluminium Casting (1903) Company, Limited, Sterling Metals, Limited, and other companies.

Stock and Sales of Non-ferrous Scrap

The Ministry of Supply announces that the stock of non-ferrous scrap on charge on May 31 was 43,082 tons, made up as follows:—Muffled S.A.A., 2,316 tons; lead and lead alloy, 1,002; copper and copper alloy, 15,528; zinc and zinc alloy, 6,521; other grades, 17,715 tons.

Sales for the two months' period April to May amounted to 12,705 tons (approximate value £850,000). The analysis was as follows:—Muffled and/or mechanically treated S.A.A., 2,964 tons; copper and copper alloy, 2,324; lead and lead alloy, 4,494; other grades (including zinc and zinc alloy), 2,923 tons.

Material put out to tender during the period amounted to 5,353 tons, of which 1,219 tons were lead. During the April-May period, 17,091 tons were invoiced, the value being £1,297,043.

Edward Curran Engineering Company

The memoranda of association of the Edward Curran Engineering Company, Limited, a newly formed company, make provision for a permanent link with the founder of the original business. The article states: "The board shall always include at least one male descendant of Edward Curran, deceased, bearing the surname 'Curran' provided there is such a person able and willing to act as such." Edward Curran was the founder of Edward Curran & Company, Limited, hollow-ware manufacturers, etc., of Cardiff. This company is to amalgamate with the businesses of Curran Bros., Limited, Curran Products, Limited, and Curran Machine Tools, Limited, and the ensuing combine is to be acquired by the Edward Curran Engineering Company, Limited, which has been registered as a private company with a capital of £400,000.

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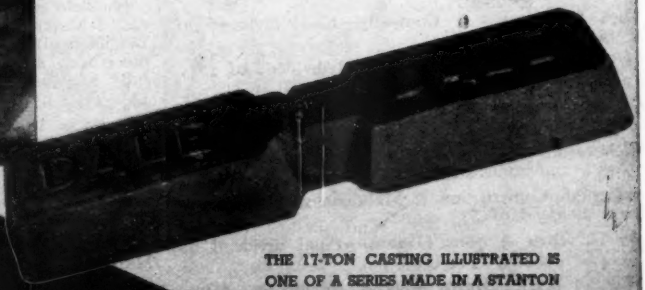

THE 17-TON CASTING ILLUSTRATED IS ONE OF A SERIES MADE IN A STANTON FOUNDRY FROM STANTON DALE IRON

1. Core being lowered into mould
2. Pouring the metal
3. Finished casting in transit

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Company News

(Figures for previous year in brackets.)

British Timken—Dividend of 15% (same).

J. & E. Hall—Interim dividend of 2½% (nil).

Kendall & Gent—Interim dividend of 5% (same).

Frederick Sage & Company—Dividend of 6% (8%).

John Sadd & Sons—Final dividend of 30%, making 45%.

C. H. Bailey—Final dividend of 12½%, making 20% (15%).

Tredegar Iron & Coal Company—Dividend of 9% (same).

Charles Neil & Company—Interim dividend of 25%, tax free (same).

Crossley Bros.—Final dividend of 8½% (12½%), making 12½% (same).

Beeston Boiler Company—Final dividend of 27½%, making 37½% (same).

Hick, Hargreaves & Company—Final dividend of 8%, making 10% (same).

H. J. Baldwin & Company—Final dividend of 15% (20%), making 25% (20%).

Consett Iron Company—Final dividend of 10% (same), making 12½% (10%).

Richardsons Westgarth & Company—Dividend of 10% (8% and bonus of 4%).

Telegraph Construction & Maintenance Company—Interim dividend of 5% (same).

W. G. Allen & Sons (Tipton)—Final dividend of 5% (7½%), making 7½% (10%).

Midland Bright Drawn Steel & Engineering Company—Interim dividend of 20%.

Briton Ferry Steel Company—Final dividend of 12½% (7½%), making 15% (10%).

A.B.C. Coupler & Engineering Company—Dividend of 20% (15% and bonus of 2½%).

Walsall Conduits—Final dividend of 35% (same) and bonus of 15% (nil), making 70% (55%).

British Vacuum Cleaner & Engineering Company—Dividend of 20% (13¾%), making 20% (same).

A. Kershaw & Sons—Full dividend on the 12½% "B" preference shares in respect of the year 1946 (6¼% for 1945).

J. Stone & Company—Net profit for 1946, after tax, depreciation, etc., £242,828 (£228,155); to reserve, £50,000 (same); final dividend of 15%, making 25% (same); forward, £346,443 (£342,715).

Romac Industries—Profit for the year ended September 30 last, £17,860 (£14,404); to tax, £8,935 (£7,186); general reserve, £2,000 (same); dividend of 7½% (same) and bonus of 2½% (same); forward, £2,036 (£501).

Francis Morton & Company—Profits for the year ended March 31, £22,041 (£25,815); to general reserve, £17,000 (nil); final dividend of 7½% (same) and bonus of 2½% (5%), making 17½% (20%); forward, £51,942 (£65,289).

Monks, Hall & Company—Net profit for the year ended March 29, after tax, £76,880 (£77,938, after crediting income tax over-provided and E.P.T. refund); final dividend of 3s. (same), making 58s. (59s.); forward, £3,127 (£2,630).

British Thermostat Company—Net profit for the year ended January 31, £130,031 (£107,782); reserve written back no longer required, £4,704 (nil); to taxation, £88,000 (same); final dividend of 11% (same and a bonus of 5%), making 23½% (18½%); forward, £47,219 (£21,651).

Sydney S. Bird & Sons—Profit for 1946, after E.P.T., £34,794 (£29,532 for 15 months); to directors' fees, £900 (£975); depreciation, £3,314 (£2,935); tax, £15,000 (£12,500); net profit, £15,580 (£13,122); to general reserve, £10,000 (nil); dividend of 30% (37½%); forward, £10,380 (£13,874).

Sheffield Steel Products—Trading profit for the year ended March 31, £137,397 (£63,077); net profit, after £44,500 (nil) for tax, and £55,000 (£35,000) for depreciation, £35,157 (£16,722); E.P.T. refund, £17,495 (nil); to general reserve, £35,000 (£8,861); dividend of 15% (7½%); forward, £28,998 (£26,698).

Coltness Iron Company—Full report shows: Profit for 1946, £372,025 (£374,111); provision for taxation, nil (£95,000); written off for redemption and depreciation, £8,000 (£85,000); directors' fees, £4,000 (£3,904); second interim dividend of 2s. 6d. per share, making 3s. 3d. (same); forward, £504,985 (£298,678).

Tilling-Stevens—Net profit for the year ended March 31, after depreciation, etc., £47,919 (£62,153); to tax, £20,000 (£44,500); adjustment in respect of E.P.T., £13,000 (nil); maintenance of buildings, nil (£5,000); dividend of 5% (same); general reserve, £20,000 (£15,000); forward, £44,453 (£55,655).

Whitehead Iron & Steel Company—Net profit for the year ended March 31, after taxation, £325,513 (£220,852); E.P.T., £124,000 (£51,000); income tax, £221,000 (£114,500); to special depreciation, nil (£40,000); general reserve, £190,000 (£140,000); final dividend of 17½%, making 30% (20%); forward, £60,846 (£54,666).

Richard Thomas & Baldwins—Trading balance for the year ended March 29, £5,064,178 (£4,184,601); dividends from trade investments, £174,736 (£123,854); to fees, £7,416 (£7,111); debenture and loan interest, £315,789 (£337,940); staff pension scheme, etc., £59,240 (£50,927); depreciation, £1,192,805 (£1,061,357); taxation, £2,420,000 (£1,715,000); net profit, £1,243,664 (£1,136,120); dividends from a subsidiary now in voluntary liquidation, £19,739 (£152,702); to deferred repairs, £100,000 (nil); pensions, etc., £120,000 (nil); premium to preference shareholders of Grovesend Steel & Tinplate Company, Limited, nil (£62,500); general reserve, £150,000 (same); preference dividend, £111,553 (£101,411); additional 3½% on preference, £60,067 (same); final ordinary dividend of 10%, making 15% (12½%); forward, £1,083,287 (£997,442).

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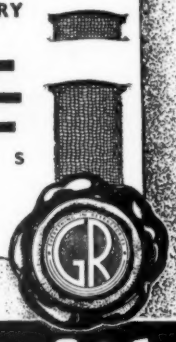

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Raw Material Markets

Iron and Steel

Foundrymen continue to experience the greatest difficulty in obtaining sufficient pig-iron to maintain continuity of operations, even on the limited scale imposed by the shortage of labour. Foundry coke is in rather better supply, but what is now required as a matter of some urgency is the expansion of high-phosphorus pig-iron production, which can only be achieved by the employment of additional blast furnaces. In the meantime, the issue of licences for foundry iron is severely curtailed and every application is subject to the closest scrutiny. The position in regard to low-phosphorus, refined and hematite iron is less stringent, but more basic iron is now called for as a prelude to the expansion of the output of steel ingots.

Neither at the sheet works nor the re-rolling mills is it possible to achieve full production owing to the scarcity of sheet bars, billets, etc. This is all the more lamentable since the demand for this class of material is quite unprecedented. Export quotas have had to be reduced, because of the urgency of home requirements, and export prices advanced, without visibly affecting the volume of overseas inquiries. Possibilities of expanding the intake of semis from overseas are being continuously explored, but there is still no precise information as to the success of these efforts, and most of the mills are working on a hand-to-mouth basis.

For several months past non-priority users of plates and sections have been receiving deliveries which are well below their minimum requirements, and there seems little chance of any real improvement in the near future. Shipbuilders are already involved in serious difficulties, and in the engineering trades a lot of work is held up owing to the scarcity of supplies of structural steel. Users have to submit to long waiting periods for even the most urgently needed tonnages and the consequent dislocation of industry is becoming very serious.

Non-ferrous Metals

The Control of Non-ferrous Metals (No. 29) (Copper, Lead and Zinc) Order, 1947, came into force on Monday. This Order further varies the No. 22 Order. It reduces the maximum price of copper, increases the margin for black hot-rolled copper wire rods, and provides for higher premiums on copper shapes. The maximum price for high conductivity electrolytic copper is reduced by £5 per ton from £137 to £132 per ton, delivered. Prices for other descriptions of copper are correspondingly adjusted, except in the case of black hot-rolled copper wire-rods, the new price for which is £138 per ton, against £142, for which the margin over the copper price is now £6 per ton in place of £5. The reduction in the copper price reflects the lower price at which the Ministry of Supply is now buying copper overseas.

The premiums on a variety of copper shapes are increased by varying amounts of between 15s. and £1 10s. per ton to bring them more into line with the Ministry's costs. Some shapes not hitherto covered by Order are also listed. The Order also authorises the performance of pre-Order contracts at the old prices. Copies of the Order may be obtained from H.M. Stationery Office, York House, Kingsway, London, W.C.2, price 1d. (S.R. & O., No. 1,447, 1947).

The Ministry of Supply has announced the withdrawal of the restriction whereby the issue of licences for copper, zinc and tin metal, as supplied by the Directorate of Non-ferrous Metals, was limited in accordance with the applicant's rate of consumption, stock and forward purchases. Thus, applicants for licences (and contracts) for these metals will, in future, need to give only the one guarantee that their application is against orders for their products, full allowance having been made for their intake of scrap. As regards lead, the similar restriction applying to contracts (instead of licences) issued by the Directorate is also withdrawn.

Obituary

MR. DAVID BRUCE CRAIG, of D. Craig & Sons, iron-founders, of Millerhill, near Dalkeith, Midlothian, died last week.

MR. LAUCHLIN MACLEAN, works manager of MacRae & Dick, Limited, motor engineers, of Inverness, died suddenly on July 5.

MR. NORMAN BLAKEY, secretary of Short Bros., Limited, shipbuilders, of Sunderland, since 1939, has died at the age of 55.

MR. ROBERT SINCLAIR KENNEDY, who died at Oundle on July 2, was a director of the Railway & General Engineering Company, Limited.

MR. WILLIAM COLEMAN CHRISTY, managing director of Christy & Norris, Limited, manufacturing engineers, etc., of Chelmsford, died on July 5, aged 72.

MR. WILLIAM VERNON HASLAM, who has died at the age of 67, had been chief of the maintenance department of the Bryan Donkin Company, Limited, Chesterfield, for 45 years.

MR. ARTHUR THOMAS ATKINS, who for more than 30 years was Sheffield representative of Stewarts and Lloyds, Limited, died recently. He opened the Sheffield branch in 1909 and became well known throughout South Yorkshire.

MR. JOHN MATHIESON, who retired in January from the post of agent with the Consett Iron Company, Limited, after 50 years with the firm, has died at the age of 77. Before being appointed agent, he was sales manager with the company.

MR. JAMES MACGREGOR died on July 7 at the age of 85. He was active until a short time ago as a director of A. R. Heathcote & Company, Limited, machine-knife manufacturers, of Sheffield. Previously he was for many years engineer and steelworks manager of Sanderson Bros. & Newbold, Limited.